

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested.

This Amendment is in response to the Office Action dated March 9, 2004. Appreciation is expressed for the indication of allowable subject matter with regard to claims 20, 21, 23 and 24.

By the present Amendment, the first sentence of the specification has been amended as requested in paragraph 2 of the Office Action. Accordingly, reconsideration and removal of the objection to the specification set forth in that paragraph is respectfully requested.

Briefly, the present claims are directed to features of the present invention regarding the combination of a gate electrode having a corresponding diffusion layer, a connection layer disposed above the gate electrode with an insulating layer interposed therebetween, and a plug electrically connected to the connection layer and the diffusion layer. With regard to this, at least one of the gate, the plug and the connection layer includes copper as a main constituent element. The present claims are directed to various features of the construction of one or more of the gate electrode, the connection layer and the plug within this overall combination of elements to avoid a lattice mismatch which could cause internal fractures due to copper migration caused by the lattice mismatch.

Referring to Fig. 1, solely for purposes of example, gate electrodes 8 and 9 are shown above a silicon substrate 1, with gate insulators 6 and 7 respectively located therebetween. The plug is formed of a main conductive film 15 and adjacent conductive films 14a and 14b. Insulators 12 and 13 are interposed between the gate

electrodes 8 and 9 and the plugs. Connection layers are formed by a main conductive layer 17 and adjacent conductive layers 16a and 16b. These connection layers are formed over the plugs (14/15) such that the plugs respectively electrically connect the connection layers (16/17) and the diffusion regions (e.g., indicated by numerals 2, 3, 4 etc.).

In accordance with the present invention, copper is used as a main constituent material of at least one of the plug, the connection layer and the gate. As shown in Fig. 12 (and discussed on page 30, line 10 et seq.), the Applicants' studies have shown that lattice mismatching can lead to copper migration that can create voids, and, correspondingly, disconnections. More specifically, it can be seen that when one of rhodium, ruthenium, iridium, osmium or platinum is used as an adjacent material to the copper, the migration resistance is significantly better than in the case of the other materials tested (e.g., Ti, TiN, Hf, Zr). This is particularly discussed on page 30, line 19 through page 31, line 10 of the specification. In particular, as noted on page 31, lines 6-10:

"Accordingly, in this embodiment, since rhodium (Rh), ruthenium (Ru), iridium (Ir), osmium (Os) and platinum (Pt) whose lattice mismatching with copper (Cu) is small are used as the main constituent elements of the conductor film adjacent to the conductor film having copper (Cu) as the main constituent element, the migration resistance improves."

Reconsideration and allowance of independent claim 13 and its dependent claims 14 and 15 over the obviousness type double patenting rejection based on claim 3 of the parent U.S. Patent 6,624,513 is respectfully requested. Regarding this, it is noted that the independent claim 13 and its dependent claims 14 and 15 are all directed to a feature of the present

invention regarding the structure of the plug which connects a connection layer and a diffusion layer in the substrate. More specifically, the plug includes a main conductive film including copper as its main constituent element and an adjacent conductive film including an element selected from rhodium, ruthenium, iridium, osmium and platinum. As discussed above regarding Fig. 12, the specific structure for the plug helps prevent the lattice mismatch that can lead to copper migration and, correspondingly, fractures within the semiconductor device.

Claim 3 of the parent patent U.S. Patent No. 6,624,513 does, as recognized in the Office Action, include a copper film and a first conductive film having a main constituent element selected from rhodium, ruthenium, iridium, osmium and platinum. However, as also recognized by the Office Action, claim 3 of the parent patent completely lacks any features of the present claim 13 regarding the specific plug structure and associated elements. This plug structure reduces the copper migration, and operates in conjunction with the connection layer and the diffusion layer provided to improve the transistor operation both in terms of stability and efficient electrical characteristics.

In the Office Action, it is stated that it would be obvious to use the multilayer film of claim 3 of the parent patent as the metal contact 90 or the metal line 100 of the Bronner references. Regarding this, it is respectfully submitted that, other than the Applicants' own disclosure, there is nothing which would motivate one of ordinary skill in the art to modify the Bronner reference in this manner. As set forth in MPEP 2143.01:

“obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art.”

MPEP 2143.01 also cited the case of In re Lee, 61USPQ2D1430(fed.cir.2002), noting that this case stands for the proposition of “discussing the importance of relying on objective evidence and making specific factual findings with respect to the motivation to combine reference.”

Concerning this, certainly no such motivation exists in the Bronner reference (U.S. Patent No. 5,792,703). Bronner is completely devoid of any suggestion of the specific metals defined by independent claim 13. Therefore, it is respectfully submitted that the only motivation for making such a combination would come from Applicants’ own teachings in the specification of the parent patent! Obviously, looking to the specification of the parent patent used in a double patenting rejection to provide motivation is completely improper. In the first place, MPEP §804 on page 800-29, upper right hand column specifically states that:

“one specific difference [between a double patenting rejection and a rejection based on prior art] is that a double patenting rejection must rely on a comparison with the claims in an issued or to be used patent, whereas an obviousness rejection based on the same patent under 35 U.S.C. §102(e)/103(a) relies on a comparison with what is disclosed (whether or not claimed) in the same issued or to be issued patent.”

Similarly, as noted in the case of In re Lee cited in MPEP 2143.01,

referred to above, it is stated:

“This factual question of motivation is material to patentability, and could not be resolved on subjective belief and unknown authority. It is improper, in determining whether a person of ordinary skill would have been led to the combination of references, simply to “use that which the inventor taught against its teacher.” 61USPQ2D at 1434.

Thus, it is respectfully submitted that there is no motivation for making the modification suggested in the Office Action to the broader structure based on claim 3 of the parent patent because Bronner clearly lacks any such disclosure and claim 3 of the parent patent does not relate at all to the multilayer plug structure. In fact, it is respectfully submitted that the double patenting rejection utilizing claim 3 of the parent patent in combination with Bronner amounts to an “obvious to try” rejection which has been indicated many times by both the CCPA and the CAFC as being improper. With regard to this, the case of In re Fine, 5USPQ2D1596(fed.cir.1988) addressed the use of an obvious to try rationale in combining references, stating as following:

“Because neither Warnick nor Eads, alone or in combination, suggested the claimed invention, the Board erred in affirming the Examiner’s conclusion that it would have been obvious to substitute the Warnick nitric oxide detector for the Eads sulfur dioxide detector in the Eads system. The Eads and Warnick references disclose, at most, that one skilled in the art might find it obvious to try the claimed combination. But whether a particular combination might be “obvious to try” is not a legitimate test of patentability.” 5USPQ2D at 1599

It is urged that the same “obvious to try” rationale is being applied in

the double patenting rejection of claim 13, and that this basis for rejection is improper. Therefore, reconsideration and allowance of independent claim 13 and its dependent claims 14 and 15 over the obviousness-type double patenting rejection based on claim 3 of the parent patent in view of Bronner is respectfully requested.

Similarly, reconsideration and allowance of the independent claim 16 and its dependent claims 17 and 18 over the double patenting rejection is also respectfully requested. Like claim 13, claim 16 is directed to a combination of a plug connected to a connection layer and a diffusion layer. In this case, the claims define the connection layer as having a main conductive film including copper as a main constituent element and an adjacent conductive film in which the main constituent element is one of rhodium, ruthenium, iridium, osmium or platinum. Again, although claim 3 of the parent patent provides a general teaching regarding similar materials, it is not directed to the specific features of claim 16 and the particular multilayer structure of a connection layer in conjunction with a plug which connects the connection layer to a diffusion layer in the substrate. Like claim 13, as noted above, there is no motivation in either claim 3 of the parent patent or in the Bronner patent which would lead to the proposed modification of Bronner to arrive at the claimed structure of claim 16. Therefore, reconsideration and allowance of independent claim 16 and its dependent claims 17 and 18 over the obviousness-type double patenting rejection is also respectfully requested.

Reconsideration and allowance of independent claims 13 and 16 over

the combination of Schacham-Diamand (U.S. Patent No. 5,824,599) in view of Bronner is also respectfully requested. In the Office Action, it is noted that the Schacham-Diamand patent teaches the use of a copper plug 23 with a catalytic layer 18 that can include platinum or rhodium. The rejection relies on column 6, lines 13-18 and 45-56 as well as column 7, lines 29-35 regarding the materials of the catalytic seed layer 18. However, in column 7, lines 35-43 it is stated:

"Then, as shown in Fig. 6, electroless copper deposition growth is performed in a copper solution. The Al layer 19, as well as the underlying alloy layer in the layer 18-19 interface with will dissolve when subjected to the electroless deposition path, thereby exposing the underlying catalytic layer 18 for the electroless deposition in copper to occur. The dissolving of layer 19 allows copper to be deposited on a non-contaminated and non-oxidized copper surface of catalytic layer 18."

In other word, the additional materials such as platinum and rhodium are apparently dissolved away in the layer 18 so that "a non-contaminated and non-oxidized copper surface of the catalytic layer 18" is all that remains. In other words, the platinum and rhodium will apparently be gone by the time the copper plug 23 is formed over the uncontaminated copper layer 18. As such, the combination of a copper layer 23 with adjacent rhodium and platinum never actually takes place in the Schacham-Diamand structure.

Nothing in Bronner suggests anything to modify the Schacham-Diamand with regard to the above-noted shortcoming in meeting the terms of claims 13 and 16. Indeed, as pointed out before, Bronner lacks any teaching or suggestion of the use of the claimed materials of the adjacent conductive

films (either of plug or the connection layer). Therefore, reconsideration and allowance of independent claims 13 and 16 over the combination of Schacham-Diamand and Bronner is respectfully requested.

Finally, reconsideration and allowance of independent claims 19 and 22 over the references to Bronner and Psaras (U.S. Patent No. 4,803,539) is also respectfully requested. As recognized in the Office Action, the reference to Bronner fails to teach either a gate electrode with rhodium, ruthenium, iridium, osmium and platinum as a main constituent. As also recognized in the Office Action, Bronner fails to teach a multilayer gate electrode with a first conductive film that includes silicon and a second conductive film, nearer the plug, that includes one of the above-noted materials. However, Psaras is cited with regard to its teachings of rhodium silicide for motivating the modification of Bronner to provide the claimed multilayer gate electrode.

In response to this, it is noted that Psaras uses a silicide, specifically rhodium silicide, which is a completely difference material than rhodium. Therefore, even if Psaras was combined with Bronner, the end result would be using a polysilicon layer with an upper layer of rhodium silicide, rather than the claimed structure of a copper layer with a layer of rhodium, ruthenium, iridium, osmium and platinum. To put this another way, in order to arrive at the claimed invention, not only would one have to combine Psaras and Bronner in the first place, but one would have to modify Psaras' teachings of using a polysilicon layer to a copper layer, and then further modify Psaras' teachings of using rhodium silicide to use rhodium instead. Other than Applicants' own disclosure, there is absolutely no motivation to be found in


either Psaras or Bronner for making these modifications which would be necessary to the combined structure. Therefore, reconsideration and allowance of independent claims 19 and 22 over the combination of Bronner and Psaras is respectfully requested.

If the Examiner believes that there are any other points which may be clarified or otherwise disposed of, either by telephone discussion or by personal interview, the Examiner is invited to contact applicants' undersigned attorney at the number indicated below.

To the extent necessary, the applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, Deposit Account No. 01-2135 (500.39912CX1).

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

By 
Gregory E. Montone
Reg. No. 28,141

GEM/btd

1300 North Seventeenth Street, Suite 1800
Arlington, Virginia 22209
Telephone: (703) 312-6600
Facsimile: (703) 312-6666